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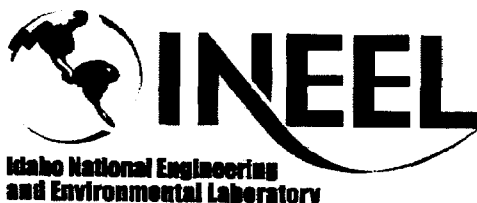
QA RECORD

Engineering Design File

PROJECT FILE NO. 015722

INTEC Tank Farm Tank Closure Grouping Evaluation

Prepared for:
U.S. Department of Energy
Idaho Operations Office
Idaho Falls, Idaho



ENGINEERING DESIGN FILE

1. Title: INTEC Tank Farm Tank Closure Grouting Evaluation				
2. Project File No.: 015722				
3. Site Area and Building No.: INTEC TFF		4. SSC Identification/Equipment Tag No.:		
5. Summary: This EDF evaluates the grouting to be used to stabilize potential residual waste in INTEC Tank Farm tanks, and piping and determines the volume of grout necessary to comply with the Class C LLW concentration limits specified in 10 CFR 61.55. Information from various sources is referenced and used as a basis for this EDF.				
6. Review (R) and Approval (A) and Acceptance (Ac) Signatures: (See instructions for definitions of terms and significance of signatures.)				
	R/A	Typed Name/Organization	Signature	Date
Performer		Randy Eastman/ Facilities Design	<i>Randy Eastman</i>	11-14-01
Checker	R			
Independent Peer Reviewer	A	Dan Staiger	<i>Dan Staiger</i>	19 Nov 01
Approver	A			
Requestor	Ac	Baird McNaught/Project Management Fuel/Waste Management	<i>W. Baird McNaught</i>	19 Nov 01
7. Distribution: (Name and Mail Stop) BAIRD McNAUGHT, MS 3211 ; DAN STAIGER, MS 3211				
8. Records Management Uniform File Code (UFC): 8204 8302				
Disposition Authority: DC A17-30-C-1			Retention Period: SEE DMCS	
EDF pertains to NRC licensed facility or INEEL SNF program?: <input type="checkbox"/> Yes <input type="checkbox"/> No				
9. Registered Professional Engineer's Stamp (if required)				

1.0 Introduction

The purpose of this EDF is to determine if the grouting that will be used to stabilize residual waste in the INTEC Tank Farm (TFF) eleven 300,000 gal underground storage tanks, four 30,000 gal storage tanks, and associated process piping will meet Class C LLW concentration limits per 10 CFR Part 61. The grout thickness necessary to stabilize the residual waste will be determined using volume averaging techniques as presented in the Department of Energy, Radioactive Waste Management Technical Position Paper titled "Concentration Averaging and Encapsulation Related to Requirements for the Waste Incidental to Reprocessing Determinations of DOE M 435.1-1, Section II.B.(2)" (Reference 1). Information from various references will be used to form the basis of the analysis presented in this EDF.

Waste classification for near surface disposal is described in 10 CFR 61.55, "Waste Classification." The NRC concentration limits in 10 CFR 61.55 are for classification of waste as a particular type (Class A, B, C, or Greater Than Class C (GTCC)). The classification scheme from 10 CFR 61.55 is provided below:

2.0 10 CFR 61.55 Waste Classification

(a) Classification of waste for near surface disposal. (1) *Considerations.* Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors) whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.

(2) *Classes of waste.* (i) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in §61.56(a). If Class A waste also meets the stability requirements set forth in §61.56(b), it is not necessary to segregate the waste for disposal.

(ii) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in §61.56.

(iii) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in §61.56.

(iv) Waste that is not generally acceptable for near-surface disposal is waste for which form and disposal methods must be different, and in general more stringent, than those specified for Class C waste. In the absence of specific requirements in this part, such waste must be disposed of in a geologic repository as defined in part 60 of this chapter unless proposals for disposal of such waste in a disposal site licensed pursuant to this part are approved by the Commission.

(3) Classification determined by long-lived radionuclides. If radioactive waste contains only radionuclides listed in Table 1, classification shall be determined as follows:

- (i) If the concentration does not exceed 0.1 times the value in Table 1, the waste is Class A.
- (ii) If the concentration exceeds 0.1 times the value in Table 1 but does not exceed the value in Table 1, the waste is Class C.
- (iii) If the concentration exceeds the value in Table 1, the waste is not generally acceptable for near-surface disposal.
- (iv) For wastes containing mixtures of radionuclides listed in Table 1, the total concentration shall be determined by the sum of fractions

Table 1 from 10 CFR 61.55	
Radionuclide	Concentration curies per cubic meter
C-14	8
C-14 in activated metal	80
Ni-59 in activated metal	220
Nb-94 in activated metal	0.2
Tc-99	3
I-129	0.08
Alpha emitting transuranic nuclides with half-life greater than 5 years	¹ 100
Pu-241	¹ 3,500
Cm-242	¹ 20,000

¹Units are nanocuries per gram.

(4) Classification determined by short-lived radionuclides. If radioactive waste does not contain any of the radionuclides listed in Table 1, classification shall be determined based on the concentrations shown in Table 2. However, as specified in paragraph (a)(6) of this section, if radioactive waste does not contain any nuclides listed in either Table 1 or 2, it is Class A.

- (i) If the concentration does not exceed the value in Column 1, the waste is Class A.
- (ii) If the concentration exceeds the value in Column 1, but does not exceed the value in Column 2, the waste is Class B.
- (iii) If the concentration exceeds the value in Column 2, but does not exceed the value in Column 3, the waste is Class C.
- (iv) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.
- (v) For wastes containing mixtures of the nuclides listed in Table 2, the total concentration shall be determined by the sum of fractions rule

Table 2 from 10 CFR 61.55			
Radionuclide	Concentration, curies per cubic meter		
	Col. 1	Col. 2	Col. 3
Total of all nuclides with less than 5 year half-life	700	(¹)	(¹)
H-3	40	(¹)	(¹)
Co-60	700	(¹)	(¹)
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

¹ There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other nuclides in Table 2 determine the waste to the Class C independent of these nuclides.

(5) Classification determined by both long- and short-lived radionuclides. If radioactive waste contains a mixture of radionuclides, some of which are listed in Table 1, and some of which are listed in Table 2, classification shall be determined as follows:

(i) If the concentration of a nuclide listed in Table 1 does not exceed 0.1 times the value listed in Table 1, the class shall be that determined by the concentration of nuclides listed in Table 2.

(ii) If the concentration of a nuclide listed in Table 1 exceeds 0.1 times the value listed in Table 1 but does not exceed the value in Table 1, the waste shall be Class C, provided the concentration of nuclides listed in Table 2 does not exceed the value shown in Column 3 of Table 2.

(6) Classification of wastes with radionuclides other than those listed in Tables 1 and 2. If radioactive waste does not contain any nuclides listed in either Table 1 or 2, it is Class A.

(7) The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each nuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains Sr-90 in a concentration of 50 Ci/m³, and Cs-137 in a concentration of 22 Ci/m³. Since the concentrations both exceed the values in Column 1, Table 2, they must be compared to Column 2 values. For Sr-90 fraction 50/150=0.33; for Cs-137 fraction, 22/44=0.5; the sum of the fractions=0.83. Since the sum is less than 1.0, the waste is Class B.

(8) *Determination of concentrations in wastes.* The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as nanocuries per gram.

3.0 Basis of Analysis

Assumptions used in the calculations presented in this EDF are the following:

1. All 300,000 gal underground storage tanks are 50 ft in diameter (As-built drawings)
2. The grout specific gravity is 2.1 (Reference 6)
3. The 300,000 gallon tank heel consists of 27% solids and 73% liquids (Reference 5, Section 2.3).
4. The vertical walls of the 300,000 gal storage tanks have a residual waste thickness of 1/8" after cleaning.
5. The 30,000 gal storage tank walls have a residual waste thickness of 2 mils after cleaning.
6. The piping has a residual waste thickness of 2 mils after cleaning.
7. The bounding radionuclide inventory for the 300,000 gal storage tank 1" heel will be used as the basis to determine the residual waste inventory for the 300,000 gal tank walls, 30,000 gal tank walls, and the piping. The residual inventory for the 300,000 gal tank walls will be determined by dividing the wall residual volume by the 300,000 gal tank heel volume and multiplying this fraction times the 300,000 gal tank heel inventory. The residual inventory for the 30,000 gal tanks and the piping will be determined using the same approach.
8. The bounding radionuclide inventory for the heel in the 300,000 gal underground storage tanks is as defined in the Performance Assessment report for the TFF (Reference 5) modified by updated inventory data provided by Portage, Inc. (October 2001). See Table 9 within this EDF.
9. After all cleaning has been performed, the heel thickness will be 1" in the 300,000 gallon storage tanks.

4.0 Discussion of Calculations and Results

300,000 Gal Underground Storage Tank Grouting

One of the final steps in the closure of the 300,000 gal underground storage tanks will be to install grout in the tanks to stabilize and solidify any remaining waste. Prior to grouting, washing and cleaning of the storage tanks will be performed to reduce the tank overall internal contamination. A steam jet pump will be used to remove as much heel as possible during washing operations. As stated above it will be assumed that the heel can be drawn down to a thickness of 1" above the bottom of the tank. Prior to grouting this assumption will be verified by confirmatory samples.

Grout will be installed in the tanks in accordance with the results of the full-scale grout mockup test (See Reference 3). The grout mockup test successfully proved that the heel could be reduced by installing grout in five separate pours in specific patterns to push the heel toward the jet pump suction. Although this method of grout installation will result in a reduction of the heel, no credit will be taken in this analysis for the additional heel removal in determining the volume of grout required to meet Class C LLW concentration limits.

After the installation of the grout in the five pour sequence, a sixth pour will be placed to cover the previous five pours to fill remaining voids and cap and further stabilize the residual waste. The nominal thickness of the initial five pours, based on the mockup testing, was about 18 inches representing approximately 110 cu yards of grout. Each foot of tank depth represents approximately 73 cu yards of volume. The sixth pour or cap will add at least another 225 cu yards of grout for a total grout depth for the six pours of about 3.1 ft. With a total of 3.1 ft of grout and a bounding inventory for a 1" heel, the Class C LLW limits will be met (See Tables 1 & 2 with this EDF).

Table 1 identifies the parameters used to determine the total volume of residual waste and grout. Table 2 calculates the Class C LLW values based on the Table 9 bounding inventory for a 1" heel and Table 1 values and then compares these values against the Class C LLW concentration limits. The Sum of the

Fraction numbers shown in Table 2 must be less than 1 for both the short-life and long-life radionuclides to comply with the Class C LLW concentration limits.

300,000 Gal Underground Storage Tank Wall Residual Waste Grouting

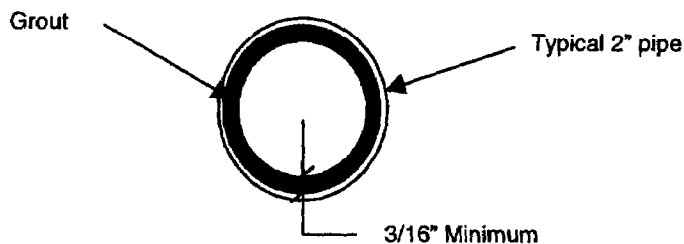
In addition to the heel in the bottom of the 300,000 gallon storage tanks, some residual contamination may remain adhered to the tank walls even after cleaning has occurred. The residual contamination will be assumed to be 1/8" thick covering the inner vertical tank walls. (See Table 3). The tank wall cleanliness and any residual waste will be verified prior to tank grouting. Table 4 shows that if 12 inches of grout covers the inner wall surface, then a layer of up to 1/8" of residual contamination (based on the volume fraction of the 1" heel bounding waste inventory) can remain and the Class C LLW concentration limits will be met. When the tank is fully grouted, the residual contamination will be encapsulated between the tank wall and the grout.

30,000 Gal Storage Tank Grouting

The INTEC Tank Farm also contains four 30,000 gallon, horizontal storage tanks. Each tank has been assumed to have a residual waste layer of 2 mils thickness. Each tank has a diameter of 11.5 feet and is approximately 38 ft long. Assuming flat plate heads, the inner surface area is approximately 1,581 sq ft. Assuming a 2 mil (0.002 inches) contamination thickness over the entire inner surface, the total residual would be approximately 0.26 cu. ft (See Table 5). Based on these assumptions and the volume fraction of the 1" heel bounding inventory, if at least 3/16 inch of grout covers the inner tank wall, then Class C LLW concentration limits will be met as shown in Table 6. When the tank is fully filled with grout, the residual contamination will be encapsulated between the tank wall and the grout.

Piping

EDF-015722-039 estimates the total length of process lines associated with the tank farm to be 10,600 feet. This EDF also estimated the residual waste as 0.002 inch thickness on the interior surface of the pipe which represented approximately 60 kg mass. To obtain 60 kg of residual waste, 10,300 sq ft of piping inner surface area was assumed at 0.002 inches of residual waste thickness (See Table 7). Based on these assumptions and the volume fraction of the 1" heel bounding inventory, if at least 3/16 inch of grout thickness covers the piping wall, the grout will adequately stabilize the residual waste to comply with Class C LLW concentration limits as shown in Table 8. The diagram below shows a typical piping cross-section showing the ideal grout arrangement to comply with the Class C limits.



REFERENCES

1. Department of Energy, Radioactive Waste Management Technical Position Paper "Concentration Averaging and Encapsulation Related to Requirements for the Waste Incidental to Reprocessing Determinations of DOE M435.1-1, Section II.B.(2)".
2. DOE/ID-10777, Idaho Nuclear Technology and Engineering Center Tank Farm Facility Residuals: Waste-Incidental-to Reprocessing Determination Report.
3. INEEL/EXT-99-01067, Idaho Nuclear Technology and Engineering Center Tank Farm Facility Closure TFF WM-182 Grout Mock-Up.
4. EDF-015722-039, INTEC Tank Farm Facility Closure, "Pipeline Decontamination Assessment", prepared by Mike Wilcox.
5. INEEL/EXT-2001-XX, Performance Assessment for the Tank Farm Facility at the Idaho National Engineering and Environmental Laboratory, April 2001.
6. EDF-1464, INTEC Tank Farm Closure, "Fill Grout" prepared by Scott A. Jensen.
7. Conceptual Design for the INTEC Tank Farm Facility Closure, Project File No. 015722, September 29, 2000.

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APPENDIX

Table 1
300,000 Gal Tank Conditions

SG of Liquid	1.00	
Particle SG	1.88	
Area of Tank Bottom	1,963	ft ²
Residual Heel Thickness	1.0	in
Heel Volume	164	ft ³
Heel Volume	1,224	gal
Heel Volume	4,634	l
Liquid Fraction	73.1%	
Volume of Solids	1,247	l
Volume of Liquid	3,387	l
Mass of Solids	2,343	kg
Mass of Liquid	3,387	kg
Grout SG	2.10	
Grout Depth	3.10	ft
Grout Mass	361,996	kg
Grout Volume	172,379	l
Grout Volume	225	cy
Total Mass	367,727	kg
Total Volume	177,013	l
CFR Classification	Class C	

Table 2 - 300,000 Gal Tank Grout LLW Analysis

Table 2 - 300,000 Gal Tank GROUT LLW Analysis											
Class	Class C	Class A limit (Ci/m ³)	Class B limit (Ci/m ³)	Class C limit (Ci/m ³)	GROUT Layer (Ci/m ³)	Fraction of Class A Limit	Fraction of Class B Limit	Fraction of Class C Limit	Under Class A Limit?	Under Class B Limit?	Under Class C Limit?
short lived:	Alpha Emitting (half life < than 5 years)	700	n/a	n/a	0	0	0	0	TRUE	TRUE	TRUE
	H-3	40	n/a	n/a	0.0038283	0.00009816	0	0	TRUE	TRUE	TRUE
	Co-60	700	n/a	n/a	0.000167	0.00000238	0	0	TRUE	TRUE	TRUE
	Ni-63	3.5	70	700	0.021	0.0061	0.00030	0.000030	TRUE	TRUE	TRUE
	Ni-63 in activated metal	35	700	7000	0	0	0	0	TRUE	TRUE	TRUE
	Sr-90	0.04	150	7000	52.2	1.305	0.348	0.00746	FALSE	TRUE	TRUE
	Cs-137	1	44	4800	28.0	28	0.637	0.00609	FALSE	TRUE	TRUE
	Sum of Fractions Number (should be <1)					1.333	0.99	0.0136	FALSE	TRUE	TRUE
long lived:	C-14	0.8	0.8	8	0	0	0	0	TRUE	TRUE	TRUE
	C-14 in activated metal	8	8	80	0	0	0	0	TRUE	TRUE	TRUE
	Ni-59	22	22	220	0	0	0	0	TRUE	TRUE	TRUE
	Ni-94	0.02	0.02	0.2	0.0484	2.42	0.212	0.242	FALSE	FALSE	TRUE
	Tc-98	0.3	0.3	3	0.0637	0.212	0.212	0.0212	TRUE	TRUE	TRUE
	I-129	0.098	0.008	0.08	0.0000393	0.00491	0.00491	0.000491	TRUE	TRUE	TRUE
	Alpha Emitting TRU (half life > 5 years)**	10	10	100	69.3	6.93	6.93	0.893	FALSE	FALSE	TRUE
	Pu-241*	350	350	3500	46.8	0.142	0.142	0.0142	TRUE	TRUE	TRUE
	Pu-242*	2000	2000	20000	0.00431	0.00000216	0.00000216	0.00000216	TRUE	TRUE	TRUE
	Sum of Fractions Number (should be <1)					9.71	9.71	0.97	FALSE	FALSE	TRUE

* units of nCi/g
** units of nCi/g; includes Am-241, Am-243, Cm-244, Np-237, Pu-238, Pu-239, Pu-240, Pu-242

Table 3
300,000 Gal Tank Wall Conditions

SG of Liquid	1.00	
Particle SG	1.88	
Area of Tank Wall	3,613	ft ²
Residual Thickness	0.125	in
Residual Volume	37.6	ft ³
Residual Volume	281.5	gal
Residual Volume	1065.8	l
Liquid Fraction	73%	
Volume of Solids	286.7	l
Volume of Liquid	779.1	l
Mass of Solids	539.0	kg
Mass of Liquid	779.1	kg
Grout SG	2.10	
Grout Depth	1.0	ft
Grout Mass	214,862	kg
Grout Volume	102,315	l
Grout Volume	133,809	cy
Total Mass	216,180	kg
Total Volume	103,381	l
CFR Classification	Class C	

Table 4 - 300,000 Gal Tank Wall Grout LLW Analysis

Class	Definermination:	Class C	Class A limit (C/m ³)	Class B limit (C/m ³)	Class C limit (C/m ³)	Grout Layer (C/m ³)	Fraction of Class A Limit	Fraction of Class B Limit	Fraction of Class C Limit	Under Class A Limit?	Under Class B Limit?	Under Class C Limit?
	short lived:											
		Alpha Emitting (half life < than 5 years)										
		H-3	700	n/a	n/a	0	0	0	0	TRUE	TRUE	TRUE
		Co-60	40	n/a	n/a	0.0015462	0.00003866	0	0	TRUE	TRUE	TRUE
		Ni-63	700	n/a	n/a	0.00086	0.00000094	0	0	TRUE	TRUE	TRUE
		Ni-63 in activated metal	3.5	70	700	0.008	0.0024	0.00012	0.000012	TRUE	TRUE	TRUE
		Sr-90	35	700	7000	0	0	0	0	TRUE	TRUE	TRUE
		Cs-137	0.04	150	7000	20.6	514	0.137	0.00284	FALSE	TRUE	TRUE
		Sum of Fractions Number (should be <1)	1	44	4800	11.0	525	0.39	0.0053	FALSE	TRUE	TRUE
	long lived:											
		C-14	0.8	0.8	8	0	0	0	0	TRUE	TRUE	TRUE
		C-14 in activated metal	8	8	80	0	0	0	0	TRUE	TRUE	TRUE
		Ni-59	22	22	220	0	0	0	0	TRUE	TRUE	TRUE
		Ni-94	0.02	0.02	0.2	0.0191	0.95	0.95	0.095	TRUE	TRUE	TRUE
		Tc-99	0.3	0.3	3	0.0251	0.084	0.084	0.0084	TRUE	TRUE	TRUE
		I-129	0.008	0.008	0.08	0.000155	0.00193	0.00193	0.000193	TRUE	TRUE	TRUE
		Alpha Emitting TRU (half life > 5 years)**	10	10	100	27.1	2.71	2.71	2.71	FALSE	FALSE	TRUE
		Pu-241*	350	350	3500	19.5	0.056	0.056	0.0066	TRUE	TRUE	TRUE
		Cm-242*	2000	2000	20000	0.00169	0.00000084	0.00000084	0.00000084	TRUE	TRUE	TRUE
		Sum of Fractions Number (should be <1)					3.80	3.80	0.38	FALSE	FALSE	TRUE

* units of nCi/g
 ** units of nCi/g; includes Am-241, Am-243, Cm-244, Np-237, Pu-238, Pu-239, Pu-240, Pu-242

Table 5 30,000 Gal Tank Conditions		
SG of Liquid	1.00	
Particle SG	1.88	
Total Tank Wall Area	1581	ft ²
Residual Waste Thickness	0.002	in
Residual Waste Volume	0.26	ft ³
Residual Waste Volume	1.97	gal
Residual Waste Volume	7.46	l
Liquid Fraction	73%	
Volume of Solids	2.01	l
Volume of Liquid	5.45	l
Mass of Solids	3.79	kg
Mass of Liquid	5.45	kg
Grout SG	2.10	
Grout Depth	0.012	ft
Grout Mass	1,128	kg
Grout Volume	537	l
Grout Volume	1	cy
Total Mass	1,137	kg
Total Volume	545	l
CFR Classification	Class C	

Table 6 30,000 Gal Tank Grout LLW Analysis

Table 6 30,000 Gal Tank Grout LLW Analysis										
Class	Class C	Class A limit (Ci/m ³)	Class B limit (Ci/m ³)	Grout Layer (Ci/m ³)	Fraction of Class A Limit	Fraction of Class B Limit	Fraction of Class C Limit	Under Class A Limit?	Under Class B Limit?	Under Class C Limit?
short lived:	Alpha Emitting (half life < than 5 years)	700	n/a	n/a	0	0	0	TRUE	TRUE	TRUE
	H-3	40	n/a	n/a	0.0020546	0.00005138	0	TRUE	TRUE	TRUE
	Co-60	700	n/a	n/a	0.00087	0.00000125	0	TRUE	TRUE	TRUE
	Ni-63	3.5	70	700	0.011	0.0032	0.000016	TRUE	TRUE	TRUE
	Ni-63 in activated metal	35	700	7000	0	0	0	TRUE	TRUE	TRUE
	Sr-90	0.04	150	7000	27.3	683	0.182	FALSE	TRUE	TRUE
	Cs137	1	44	4800	14.7	15	0.333	FALSE	TRUE	TRUE
	Sum of Fractions Number (should be <1)				698	0.52	0.0071	FALSE	TRUE	TRUE
long lived:	C-14	0.8	0.8	8	0	0	0	TRUE	TRUE	TRUE
	C-14 in activated metal	8	8	80	0	0	0	TRUE	TRUE	TRUE
	Ni-59	22	22	220	0.00010	0.00000044	0.00000044	TRUE	TRUE	TRUE
	Nb-94	0.02	0.02	0.2	0.0253	1.27	0.127	FALSE	FALSE	FALSE
	Tc-99	0.3	0.3	3	0.0334	0.111	0.0111	TRUE	TRUE	TRUE
	I-129	0.008	0.008	0.08	0.000205	0.00257	0.000257	TRUE	TRUE	TRUE
	Alpha Emitting TRU (half life > 5 years)**	10	10	100	36.1	3.61	0.361	FALSE	FALSE	FALSE
	Pu-241*	350	350	3500	25.9	0.074	0.0074	TRUE	TRUE	TRUE
	Cm-242*	2000	2000	20000	0.00225	0.00000112	0.000000112	TRUE	TRUE	TRUE
	Sum of Fractions Number (should be <1)				5.06	5.06	0.51	FALSE	FALSE	FALSE

* units of nCi/g
** units of nCi/g; includes Am-241, Am-243, Cm-244, Np-237, Pu-238, Pu-239, Pu-240, Pu-242

**Table 7
Piping Conditions**

SG of Liquid	1.00	
Particle SG	1.88	
Estimated Pipe Surface Area	10300	ft ²
Residual Waste Thickness	0.002	in
Residual Waste Volume	1.7	ft ³
Residual Waste Volume	13	gal
Residual Waste Volume	49	l
Liquid Fraction	73%	
Volume of Solids	13	l
Volume of Liquid	35	l
Mass of Solids	25	kg
Mass of Liquid	35	kg
Grout SG	2.10	
Grout Depth	0.015	ft
Grout Mass	9,188	kg
Grout Volume	4,375	l
Grout Volume	6	cy
Total Mass	9,249	kg
Total Volume	4,424	l
CFR Classification	Class C	

Table 8 Piping Gout LLW Analysis												
Class	Class C	Class A limit (C/m ³)	Class B limit (C/m ³)	Class C limit (C/m ³)	Gout Layer (C/m ³)	Fraction of Class A Limit	Fraction of Class B Limit	Fraction of Class C Limit	Under Class A Limit?	Under Class B Limit?	Under Class C Limit?	
short lived:												
	Alpha Emitting (half life < than 5 years)	700	n/a	n/a	0	0	0	0	TRUE	TRUE	TRUE	
	H-3	40	n/a	n/a	0.0016482	0.00004120	0	0	TRUE	TRUE	TRUE	
	Co-60	700	n/a	n/a	0.00070	0.0000100	0	0	TRUE	TRUE	TRUE	
	Ni-63	3.5	70	700	0.008	0.0028	0.0013	0.000013	TRUE	TRUE	TRUE	
	Ni-63 in activated metal	35	700	7000	0	0	0	0	TRUE	TRUE	TRUE	
	Sr-90	0.04	150	7000	21.9	548	0.148	0.00313	FALSE	TRUE	TRUE	
	Cs-137	1	44	4600	11.8	12	0.287	0.00256	FALSE	TRUE	TRUE	
	Sum of Fractions Number (should be <1)					560	0.41	0.0057	FALSE	TRUE	TRUE	
long lived:												
	C-14	0.8	0.8	8	0	0	0	0	TRUE	TRUE	TRUE	
	C-14 in activated metal	8	8	80	0	0	0	0	TRUE	TRUE	TRUE	
	Ni-59	22	22	220	0.00008	0.0000035	0.0000035	0.0000035	TRUE	TRUE	TRUE	
	Nb-94	0.02	0.02	0.2	0.0003	1.02	1.02	0.102	FALSE	TRUE	TRUE	
	Tc-99	0.3	0.3	3	0.0288	0.069	0.069	0.0089	TRUE	TRUE	TRUE	
	I-129	0.008	0.008	0.08	0.000165	0.00206	0.00206	0.000206	TRUE	TRUE	TRUE	
	Alpha Emitting TRU (half life > 5 years)**	10	10	100	28.9	2.89	2.89	0.289	FALSE	TRUE	TRUE	
	Pu-241*	350	350	3500	20.8	0.059	0.059	0.0059	TRUE	TRUE	TRUE	
	Gm-242*	2000	2000	20000	0.00180	0.0000080	0.0000080	0.0000080	TRUE	TRUE	TRUE	
	Sum of Fractions Number (should be <1)					4.08	4.08	0.41	FALSE	FALSE	TRUE	

* units of mCi/g

** units of mCi/g; includes Am-241, Am-243, Cm-244, Np-237, Pu-238, Pu-239, Pu-240, Pu-242

Table 9
300,000 Gal Tank Heel Inventory

	Units	Liquid in 1" Heel	Solids in 1" Heel	Total @ 1" Heel
²⁰⁷ Tl	Ci	1.71E-06	5.73E-06	7.44E-06
²⁰⁸ Tl	Ci	2.06E-05	6.88E-05	8.94E-05
²⁰⁹ Tl	Ci	2.51E-10	8.41E-10	1.09E-09
²⁰⁹ Pb	Ci	1.14E-08	3.82E-08	4.96E-08
²¹⁰ Pb	Ci	1.71E-07	5.73E-07	7.44E-07
²¹¹ Pb	Ci	1.71E-06	5.73E-06	7.44E-06
²¹² Pb	Ci	5.94E-05	1.99E-04	2.58E-04
²¹⁴ Pb	Ci	4.00E-07	1.34E-06	1.74E-06
^{210m} Bi	Ci	6.63E-21	2.22E-20	2.88E-20
²¹⁰ Bi	Ci	1.71E-07	5.73E-07	7.44E-07
²¹¹ Bi	Ci	1.71E-06	5.73E-06	7.44E-06
²¹² Bi	Ci	5.71E-05	1.91E-04	2.48E-04
²¹³ Bi	Ci	1.14E-08	3.82E-08	4.96E-08
²¹⁴ Bi	Ci	4.00E-07	1.34E-06	1.74E-06
²¹⁰ Po	Ci	1.71E-07	5.73E-07	7.44E-07
²¹¹ Po	Ci	*	*	*
²¹² Po	Ci	3.66E-05	1.22E-04	1.59E-04
²¹³ Po	Ci	1.14E-08	3.82E-08	4.96E-08
²¹⁴ Po	Ci	4.00E-07	1.34E-06	1.74E-06
²¹⁵ Po	Ci	1.71E-06	5.73E-06	7.44E-06
²¹⁶ Po	Ci	5.94E-05	1.99E-04	2.58E-04
²¹⁸ Po	Ci	4.00E-07	1.34E-06	1.74E-06
²¹⁷ At	Ci	1.14E-08	3.82E-08	4.96E-08
²¹⁹ Rn	Ci	1.71E-06	5.73E-06	7.44E-06
²²⁰ Rn	Ci	5.94E-05	1.99E-04	2.58E-04
²²² Rn	Ci	4.00E-07	1.34E-06	1.74E-06
²²¹ Fr	Ci	1.14E-08	3.82E-08	4.96E-08
²²³ Fr	Ci	2.40E-08	8.03E-08	1.04E-07
²²³ Ra	Ci	1.71E-06	5.73E-06	7.44E-06
²²⁴ Ra	Ci	5.94E-05	1.99E-04	2.58E-04
²²⁵ Ra	Ci	1.14E-08	3.82E-08	4.96E-08
²²⁶ Ra	Ci	4.00E-07	1.34E-06	1.74E-06
²²⁸ Ra	Ci	2.06E-11	6.88E-11	8.94E-11
²²⁵ Ac	Ci	1.14E-08	3.82E-08	4.96E-08
²²⁷ Ac	Ci	1.71E-06	5.73E-06	7.44E-06
²²⁸ Ac	Ci	2.06E-11	6.88E-11	8.94E-11
²²⁷ Th	Ci	1.71E-06	5.73E-06	7.44E-06
²²⁸ Th	Ci	5.94E-05	1.99E-04	2.58E-04

Table 9 (Cont'd)
Bounding Tank Inventory

	Units	Liquid in 1" Heel	Solids in 1" Heel	Total @ 1" Heel
²²⁹ Th	Ci	1.14E-08	3.82E-08	4.96E-08
²³⁰ Th	Ci	2.74E-05	9.18E-05	1.19E-04
²³¹ Th	Ci	6.40E-04	2.14E-03	2.78E-03
²³² Th	Ci	2.17E-11	7.26E-11	9.43E-11
²³⁴ Th	Ci	6.40E-04	2.14E-03	2.78E-03
²³¹ Pa	Ci	2.97E-06	9.94E-06	1.29E-05
²³² Pa	Ci	8.91E-02	2.98E-01	3.87E-01
^{234m} Pa	Ci	6.40E-04	2.14E-03	2.78E-03
²³⁴ Pa	Ci	8.11E-07	2.71E-06	3.52E-06
²³² U	Ci	5.71E-05	1.91E-04	2.48E-04
²³³ U	Ci	7.43E-06	2.48E-05	3.22E-05
²³⁴ U	Ci	2.51E-02	8.41E-02	1.09E-01
²³⁵ U	Ci	1.20E-04	4.56E-04	5.76E-04
²³⁶ U	Ci	6.49E-05	3.40E-03	3.46E-03
²³⁷ U	Ci	1.06E-04	3.56E-04	4.62E-04
²³⁸ U	Ci	1.64E-04	2.71E-04	4.35E-04
²⁴⁰ U	Ci	2.06E-11	6.88E-11	8.94E-11
²³⁵ Np	Ci	*	*	*
²³⁶ Np	Ci	*	*	*
²³⁷ Np	Ci	3.42E-03	6.58E-03	1.00E-02
²³⁸ Np	Ci	2.17E-06	7.26E-06	9.43E-06
²³⁹ Np	Ci	6.40E-04	2.14E-03	2.78E-03
^{240m} Np	Ci	2.06E-11	6.88E-11	8.94E-11
²³⁶ Pu	Ci	3.43E-06	1.15E-05	1.49E-05
²³⁸ Pu	Ci	5.69E+00	1.57E+01	2.14E+01
²³⁹ Pu	Ci	7.03E-01	9.96E-01	1.70E+00
²⁴⁰ Pu	Ci	3.20E-01	1.07E+00	1.39E+00
²⁴¹ Pu	Ci	4.23E+00	1.41E+01	1.83E+01
²⁴² Pu	Ci	2.40E-04	8.03E-04	1.04E-03
²⁴³ Pu	Ci	*	*	*
²⁴⁴ Pu	Ci	2.06E-11	6.88E-11	8.94E-11
²⁴¹ Am	Ci	3.59E-01	4.87E-01	8.46E-01
^{242m} Am	Ci	4.46E-04	1.49E-03	1.94E-03
²⁴² Am	Ci	4.46E-04	1.49E-03	1.94E-03
²⁴³ Am	Ci	6.40E-04	2.14E-03	2.78E-03
²⁴² Cm	Ci	3.66E-04	1.22E-03	1.59E-03
²⁴³ Cm	Ci	6.40E-04	2.14E-03	2.78E-03
²⁴⁴ Cm	Ci	3.20E-02	1.07E-01	1.39E-01
²⁴⁵ Cm	Ci	9.14E-06	3.06E-05	3.97E-05

Table 9 (Cont'd)
Bounding Tank Inventory

	Units	Liquid in 1" Heel	Solids in 1" Heel	Total @ 1" Heel
²⁴⁶ Cm	Ci	5.94E-07	1.99E-06	2.58E-06
²⁴⁷ Cm	Ci	6.63E-13	2.22E-12	2.88E-12
²⁴⁸ Cm	Ci	7.20E-13	2.41E-12	3.13E-12
²⁴⁹ Cf	Ci	5.14E-13	1.72E-12	2.23E-12
²⁵⁰ Cf	Ci	2.17E-13	7.26E-13	9.43E-13
²⁵¹ Cf	Ci	8.11E-15	2.71E-14	3.52E-14
²⁵² Cf	Ci	*	*	*
³ H	Ci	1.60E-01	5.35E-01	6.95E-01
¹⁰ Be	Ci	9.14E-08	3.06E-07	3.97E-07
¹⁴ C	Ci	*	*	*
⁷⁹ Se	Ci	1.37E-02	4.59E-02	5.96E-02
⁸¹ Kr	Ci	*	*	*
⁸⁵ Kr	Ci	*	*	*
⁸⁷ Rb	Ci	8.91E-07	2.98E-06	3.87E-06
⁹⁰ Sr	Ci	8.13E+02	8.43E+03	9.24E+03
⁹⁰ Y	Ci	8.13E+02	8.43E+03	9.24E+03
⁹³ Zr	Ci	6.63E-02	2.22E-01	2.88E-01
^{93m} Nb	Ci	5.71E-02	1.91E-01	2.48E-01
⁹⁴ Nb	Ci	3.43E-02	8.53E+00	8.56E+00
⁹⁸ Tc	Ci	7.88E-08	2.64E-07	3.43E-07
⁹⁹ Tc	Ci	8.83E-01	1.04E+01	1.13E+01
¹⁰⁶ Ru	Ci	3.66E-06	1.22E-05	1.59E-05
¹⁰² Rh	Ci	1.14E-06	3.82E-06	4.96E-06
¹⁰⁶ Rh	Ci	3.66E-06	1.22E-05	1.59E-05
¹⁰⁷ Pd	Ci	4.91E-04	1.64E-03	2.13E-03
^{108m} Ag	Ci	1.26E-08	4.21E-08	5.47E-08
¹⁰⁸ Ag	Ci	*	*	*
^{109m} Ag	Ci	*	*	*
^{110m} Ag	Ci	*	*	*
¹¹⁰ Ag	Ci	*	*	*
¹⁰⁹ Cd	Ci	*	*	*
^{113m} Cd	Ci	5.48E-02	1.84E-01	2.39E-01
¹¹⁵ In	Ci	2.97E-12	9.94E-12	1.29E-11
^{119m} Sn	Ci	*	*	*
^{121m} Sn	Ci	1.71E-02	5.73E-02	7.44E-02
¹²⁶ Sn	Ci	1.26E-02	4.10E-02	5.36E-02
¹²⁵ Sb	Ci	1.49E-02	4.97E-02	6.46E-02

Table 9 (Cont'd)
Bounding Tank Inventory

	Units	Liquid in 1" Heel	Solids in 1" Heel	Total @ 1" Heel
^{126m} Sb	Ci	1.26E-02	4.21E-02	5.47E-02
¹²⁶ Sb	Ci	1.71E-03	5.73E-03	7.44E-03
¹²³ Te	Ci	1.14E-14	3.82E-14	4.96E-14
^{125m} Te	Ci	3.77E-03	1.26E-02	1.64E-02
¹²⁹ I	Ci	1.60E-03	5.35E-03	6.95E-03
¹³⁴ Cs	Ci	1.21E-02	5.24E-02	6.45E-02
¹³⁵ Cs	Ci	2.74E-02	9.18E-02	1.19E-01
¹³⁷ Cs	Ci	1.14E+03	3.82E+03	4.96E+03
^{137m} Ba	Ci	1.09E+03	3.63E+03	4.72E+03
¹³⁸ La	Ci	5.94E-12	1.99E-11	2.58E-11
¹⁴² Ce	Ci	9.14E-07	3.06E-06	3.97E-06
¹⁴⁴ Ce	Ci	1.83E-07	6.12E-07	7.95E-07
^{144m} Pr	Ci	2.17E-09	7.26E-09	9.43E-09
¹⁴⁴ Pr	Ci	1.83E-07	6.12E-07	7.95E-07
¹⁴⁴ Nd	Ci	4.91E-11	1.64E-10	2.13E-10
¹⁴⁶ Pm	Ci	2.97E-04	9.94E-04	1.29E-03
¹⁴⁷ Pm	Ci	1.71E-01	5.73E-01	7.44E-01
¹⁴⁶ Sm	Ci	8.45E-09	2.83E-08	3.68E-08
¹⁴⁷ Sm	Ci	2.28E-07	7.65E-07	9.93E-07
¹⁴⁸ Sm	Ci	1.14E-12	3.82E-12	4.96E-12
¹⁴⁹ Sm	Ci	1.04E-13	3.48E-13	4.52E-13
¹⁵¹ Sm	Ci	9.37E+00	3.13E+01	4.07E+01
¹⁵⁰ Eu	Ci	3.43E-07	1.15E-06	1.49E-06
¹⁵² Eu	Ci	4.00E-02	1.34E-01	1.74E-01
¹⁵⁴ Eu	Ci	1.82E+00	3.34E-01	2.15E+00
¹⁵⁵ Eu	Ci	2.25E-01	2.71E+00	2.94E+00
¹⁵² Gd	Ci	4.46E-14	1.49E-13	1.94E-13
¹⁵³ Gd	Ci	*	*	*
^{166m} Ho	Ci	1.37E-06	4.59E-06	5.96E-06
¹⁷¹ Tm	Ci	1.37E-13	4.59E-13	5.96E-13
⁵⁹ Ni	Ci	*	*	*
⁵⁵ Fe	Ci	*	*	*
⁶⁰ Co	Ci	1.39E-01	1.56E-01	2.95E-01
⁶³ Ni	Ci	8.68E-01	2.91E+00	3.78E+00

* Estimates approximately zero

QA RECORD EPI
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4. Addressee Name and Organization:	N/A
5. Author Name and Organization:	Baird McNaught/BBWI
6. Key Words:	evaluates the grouting to be used to stabilize potential residual waste in INTEC Tank Farm tanks, piping and determines the volume of grout necessary to comply with the Class C LLW concentration limits specified in 10 CFR 61.55, tank farm facility residual waste, <i>QA record</i>
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